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ABSTRACT

The San Francisco Math Leadership Project was started in 1984 as one of the sites of the California Mathematics Project. During the past 15 years, nearly 500 elementary and middle level classroom teachers participated by attending a year long program which included an intensive summer institute and during the year activities. One goal was to provide a program that improved teachers' effectiveness by increasing their own confidence in learning and teaching mathematics. A second goal focused on developing teachers' leadership skills so that they could share their expertise with colleagues in their schools and participate in local conferences, thus enlarging the nucleus of mathematics leaders in the San Francisco Bay Area. The primary purpose of this chapter is to describe particular aspects of the project that have helped to develop leadership among the participants. It also describes the variety of leadership activities in which the participants have engaged over the years. Many of the outcomes could not have been predicted at the beginning of this project. It is only by looking back that we can really see the total impact of this long running professional development program. (Author)

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13 The Professional Development of Effective Teacher Leaders

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The San Francisco Math Leadership Project was started in 1984 as one of the sites of the California Mathematics Project. During the past 15 years, nearly 500 elementary and middle level classroom teachers participated by attending a year long program which included an intensive summer institute and during the year activities. One goal was to provide a program that improved teachers' effectiveness by increasing their own confidence in learning and teaching mathematics. A second goal focused on developing teachers' leadership skills so that they could share their expertise with colleagues in their schools and participate in local conferences, thus enlarging the nucleus of mathematics leaders in the San Francisco Bay Area. The primary purpose of this chapter is to describe particular aspects of the project that have helped to develop leadership among the participants. It also describes the variety of leadership activities in which the participants have engaged over the years. Many of the outcomes could not have been predicted at the beginning of this project. It is only by looking back that we can really see the total impact of this long running professional development program.

In fourth grade my teacher was explaining long division. I just didn't get it. I knew I would eventually. But at that moment I was so frustrated—it seemed as though there were so many numbers and symbols all over the chalkboard.

I remember being very confused by word problems at the earliest years. I never knew where the numbers came from, but I was too afraid to ask....In high school, Geometry was a blur —I never knew when to apply the axiom I had memorized....I lasted two weeks in Algebra II and realized I didn't have a

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clue. I dropped out knowing I would never take another math class.

In college I took math and I had a foreign teaching assistant who was very hard to follow. ...The most annoying thing was he would madly write all these equations on the board, turn around to face the class, and say ' all clear? OK, I erase.' I never even had the chance to see what he was writing."

Teachers wrote these memories on the first day of the summer institute of the San Francisco Math Leadership Project. They are surprised at how easily their memories of math teachers and math learning return. Each has a story to tell and it most often involves a specific teacher who can be recalled with amazing detail even after fifteen or twenty years.

Today, those involved with mathematics education have a major challenge. How can we provide the necessary support for elementary teachers, who often have negative memories of their math experiences, so they can bring the key elements of the national mathematics reform movement to their classrooms? Every elementary classroom teacher, is, in fact, a mathematics teacher. Yet, teaching elementary school is one of only a few professions that have minimal college requirements in mathematics. It is crucial that these teachers are able to provide opportunities for all children to learn and enjoy the challenge of mathematical thought. Teaching mathematics as problem solving, as communication, as reasoning and making mathematical connections, cannot wait for high school - elementary school is where it must begin.

Project Overview and Goals

Currently completing its fifteenth year, the San Francisco Math Leadership Project (SFMLP) is one of 17 sites of the California Mathematics Project funded by the State of California. Each site is connected with either the University of California (UC) or the California State University (CSU) system of higher education.

Collaboration among the teachers, principals, school district personnel and the university faculty has contributed to the success and impact of this project. At the local site level, the school district administrators and school principals play a major role in extending the project by utilizing the talents of teacher leaders who have participated in the project. This project and the other sites of the California Mathematics Project have served as a vehicle for bringing

teachers up-to-date with the issues in the current reform movement in mathematics education and for preparing them to provide leadership. During the past 15 years, several documents have been published both at the state and national level, such as *Mathematics Framework for California Public Schools* (California State Department of Education, 1985, 1992) and *Curriculum and Evaluation Standards for School Mathematics* (National Council of Teachers of Mathematics [NCTM], 1989). Through the California Mathematics Project, there developed throughout California a network of teacher leaders, trying to implement changes, as described in these documents, in their classrooms, schools, and districts.

The overall goal of the San Francisco Math Leadership Project is to develop teacher leadership in mathematics education. More specific goals include the following:

- To provide teams of urban classroom teachers with a year-long program that will improve their own mathematical/problem-solving skills, build their confidence, and increase their effectiveness as classroom teachers.
- To provide the participants with ongoing support in two ways: through classroom visits at their school sites and monthly group meetings.
- To facilitate an outreach to other classroom teachers by preparing the participants to share their expertise with colleagues in their schools and district; by providing assistance in the development of workshops; and by funding basic math manipulative materials and resource books for each participating teacher.
- To enlarge the existing nucleus of mathematics leaders in this area by including these participants as active contributors to local conferences, to district inservice programs and to their own schools.

Overall, the San Francisco Math Leadership Project has been quite successful in engaging the enthusiasm of participating teachers and helping them to adopt new teaching methods in their own classrooms. But perhaps more importantly, the participants have emerged as math leaders. This is evidenced by promotions within the district, successful grant writing activities, extensive workshop and inservice education offerings, completion of advanced degrees, and visibility in professional math associations at the local, state, and national levels.

There are many components of this project, some of which will be described in the pages that follow. However, the primary purpose of this chapter is to describe particular aspects of the project that have helped to develop leadership among the participants.

After the summer institute I came back to school with a better understanding of what an effective math program should be. I began a new job as a resource teacher, and was able to look at the total school math program. The classes, just like mine had been, were emphasizing computation. I was able to go into classes and do math activities that emphasized other mathematical strands. As a school we focused our inservice efforts on problem solving....In the Fall we did our workshop on Logical Thinking, Measurement, and Estimation. I saw many of our ideas and strategies used in classrooms. I saw an increase in the use of books and math materials that were available in the resource room.

I entered the Math Leadership Project with skepticism. As I participated in the training, I became aware of my own growth in "understanding" math as well as my own learning style... in the fall I took the plunge...The children were enthusiastic and math period lasted 1 1/2 hours daily. Almost half of my students could not do simple computation. They were discouraged and sensed failure. As they succeeded in hands-on tasks and problem solving, their computation skills grew out of an understanding of numbers and necessity. They smelled success....I see their ability and confidence in problem solving with oral and written explanations extending into Social Studies, Science and Language Arts.

Project Structures Which Promote Teacher Leadership Development

This model for developing math leadership within a school district has three stages. The initial stage is the summer institute, attended by pairs of teachers, with preference given to teachers from the same school. This phase expands the teachers' knowledge of mathematics content and teaching strategies and begins their leadership development. This is followed by the second stage, a year-long program that includes monthly meetings and support for teachers in their classrooms. It is during this year that the teachers

begin to feel more like leaders, especially after presenting the required two workshops at their school sites. The next stage of leadership development occurs with the recognition of leadership abilities of these teachers by district personnel. This recognition opens opportunities for these teachers to move beyond their own schools and use their skills on a district-wide level.

Preconference Meeting With Principals

Before the teachers become involved in the program, principals from participating schools are invited to attend an information meeting. This is also a means of informing them about math reform, and serves well as a forum for discussing leadership roles for their teachers. Often, principals describe activities that the teacher leaders have brought to their schools, such as working with parents and teacher aides, designing a math focus for back-to-school nights, school-wide math projects, and an evening devoted to a math fair. They also share creative ways of scheduling math workshops during the year. The need for risk-taking is discussed and principals are urged to encourage the teacher leaders to feel free to take risks in their classrooms, knowing that they might not all work out exactly as planned the first time.

The effectiveness of these meetings is evidenced in the involvement of the principals in mathematics education and in their comments about the program. In the early years, very few San Francisco principals attended local math conferences; currently, there is a strong cadre of approximately 15-20 principals who regularly do so. One principal recently wrote a book chapter in which she shares details about the journey she and her teachers are taking together as they reform their mathematics program (Rosen, 1999). Following are some quotations from letters received from the principals, attesting to the effect of the project on their schools.

> *Through hand-on workshops, conferencing sessions and classroom modeling, they (the teachers who attended the institute) are currently sharing their wealth of knowledge of new expertise with all staff members. The result is a renewed interest and enthusiasm for the teaching of mathematics and problem solving at all grade levels. I am delighted that we have been so fortunate as to have benefited from this project. Most of our teachers have felt limited in their ability to teach*

> *mathematics and are quite receptive to receiving and applying these perspectives and techniques. ... The San Francisco Math Leadership Project format is exactly the model needed for teacher staff development in any area. It provides classroom teachers with the opportunity to experience themselves as the knowledgeable professionals they are.*
>
> *As a result of this enthusiasm and their creative approach to the subject there is an increased interest in math throughout the whole school. The two teachers have initiated school–wide math contests, scheduled teacher workshops, and developed a school-wide math and science fair, and by their example made the whole school more math conscious.*

Summer Institute.

The three-week intensive summer institute is a central component of the program. It is designed to allow participants to experience a variety of mathematics teaching strategies that emphasize a problem solving approach to mathematics instruction, the use of math manipulative materials, cooperative group learning, and teaching across the math strands. The institute meets for four full days for each of the three weeks. The participants are surrounded by mathematics. Teachers engage in math activities in the different areas of elementary school mathematics: geometry, measurement, number, patterns and functions, probability and statistics. Problem-solving is emphasized within the content areas and also directly included as a challenging 'Problem of the Day.' This problem is presented as the beginning activity each morning and processed at the end of each day. The teachers receive hands-on experience in working in cooperative groups and in using manipulative materials as tools to solve challenging math problems. They, in fact, become active learners of mathematics and have opportunities to examine their feelings as they assume active roles in their own learning.

Because an integral part of the project is the development of math leaders, a key aspect of the institute is the opportunity for participants to practice developing and delivering workshops utilizing innovative math instruction. During the final week of the institute, participants develop and give such a presentation to their peers. By committing to this project for one full year, the participants receive a stipend, course credit, manipulative materials and resource books for teaching mathematics.

Academic Year Activities.

During the year following the summer institute, the teachers attend monthly meetings that provide the opportunity for mutual support and sharing of ideas. These meetings have been a constant feature of this project since its inception in 1984 and continue to this day. Some of the meetings are three hours long and held after school; a few of the meetings are scheduled for a full day with substitute teachers paid through the project. Often these meetings are held at the teachers' school sites. The teachers enjoy visiting each other's schools and classrooms and obtain many ideas from seeing the different environments. For each meeting, we ask the teachers to try out lessons in their classrooms with a specific math content focus and to bring children's work to share at these meetings. They benefit from the opportunity to share their successes as well as their challenges. At each meeting there is at least one math activity as well as reflection and discussion of the workshops that teachers have given at their schools.

Since 1991, teachers have been expected to keep a portfolio of student work done during the school year. They are asked to write a reflection page on 8-10 lessons and include samples of student work for each lesson. These portfolios show the range of topics introduced to students and the thoughtfulness of the teachers as they think about ways to improve their lessons. These reflections on their own practice are also very useful to the teacher leaders when they are presenting their own workshops. Using anecdotes about their own experiences enhances their workshop and brings credibility to the presentation.

During the year following the summer institute, the teachers are also required to present two workshops at their school sites and to attend a math conference. In May a celebration dinner is held for all math leadership teachers with special recognition for the current cohort of teachers.

Over the years teachers have received classroom support from the project in a variety of ways. Sometimes, past participants, who for various reasons are on leave from their regular teaching responsibilities, are hired by the project to visit these teachers. They often teach special lessons, or help the teachers to plan and teach a particular lesson, or observe the teachers and give them feedback. The teachers generally felt very supported by visits from persons in a non-supervisory role.

There have been many different types of during-the-year activities aimed at continuing the network of teachers who have participated in earlier years. These have included grade-level planning groups for past participants, organized and led by teacher leaders and a variety of annual reunions. Some years, two or three-day retreats away from usual surroundings have provided the setting for the reunion. The summers have also provided time for one-unit mini-courses in geometry, measurement, teaching algebra through the grades, and introductory probability. Sometimes these mini-courses were offered during the school year on weekends. Most recently a very successful one-day Saturday session was provided for teachers to learn to use the Internet.

During the years 1991-1994 an advanced component, referred to as Level II, was developed to respond to the needs of teachers who had participated in past years and expressed an interest in learning more mathematics. As a result, sixty-two teachers participated in a yearlong program that included a one-week summer institute with a focus on mathematics content in the areas of geometry, measurement, and probability and statistics. There were four full-day meetings during the school year.

The leadership development of the teachers begins during this first year of participation in the project when they increase their math content knowledge, experience a variety of teaching strategies and reflect on the ways that they themselves, as well as their students, learn mathematics. This contributes to a renewed interest in and enthusiasm for the teaching and learning of mathematics that enhances their credibility as they begin to take on leadership roles. Their presentations during the final week of the summer institute along with the two workshops that they present at their school sites also play a large part in helping the teachers recognize their own potential for leadership.

Changing Teachers' Mathematical Understanding

The math content pre-test, given on the first day of each summer institute, is perhaps the least favorite activity of the participants, because it reminds them of the anxiety many still have concerning mathematics. This test serves to illustrate the areas that require the most attention as well as a means for determining where participants have made the most gains by the end of the institute. The basic mathematics concepts on this test are an important part of the

mathematics curriculum for the elementary grades. Of the 24 items on this test, more than 30 percent of the 97 participants during the years 1984-87 missed items relating to topics such as: finding areas of regular and irregular shapes; statistical terms (mean, median, mode); simple probability; locating coordinate points on a grid. Many teachers were also unable to recognize the formula for the area of a square or to convert a decimal to a percent.

A comparison of the results of the post-test, which is given on the final day of the institute, with the pre-test, showed that most of the teachers' scores had improved. Many teachers found that they could approach the problems in different ways and could think about them more carefully.

> *When I entered your project I expected instruction and materials to help me teach fourth grade math. I did not expect to gain an interest, a curiosity, a confidence, and an eagerness to acquire more mathematical experience. I did not expect to become a questioner, 'Have you tried this?' 'How do you teach that?'...I find, because of this experience, teaching and learning mathematics has become a great pleasure. ...For me, the most important effect of the Math Leadership Project has been the wonderful realization that thinking and trying are the basics of mathematics. The idea that diverse methods of inquiry are acceptable and valid. That one has nothing to lose by attempting many ways to come to a conclusion.*

They reported that at the very least they made a thoughtful attempt to solve the problems and were able to tell if their answers made sense. Table 1 presents a comparison of pre- and post-test scores for participants during the years 1984-1987. Learning mathematical content continues to be a major emphasis of this project and an essential ingredient for leadership in this area.

Self-evaluation of classrooms.

Teachers were asked to complete a self-evaluation of their own classroom practices prior to the summer institute and also at the end of the first year in the project. The data provided in Table 2 illustrates the results from the pre-post self-evaluations for the years 1987-1993. The areas of the biggest challenge for teachers were in the application of problem solving and thinking skills and having a sufficient variety of math activities available for student use.

Table 1
Results of Math Test, 1984-1987

Project Year	Pre-Test	Post-Test	Significance
1984 (n=24)	$\bar{X}$ = 19.51	$\bar{X}$ = 20.5	t = 1.1909
1985 (n=19)	$\bar{X}$ = 15.90	$\bar{X}$ = 17.7	t = 1.083
1986 (n=25)	$\bar{X}$ = 16.90	$\bar{X}$ = 19.0	t = 1.371*
1987 (n=28)	$\bar{X}$ = 14.50	$\bar{X}$ = 17.5	t = 3.047**
Combined (n=96)	$\bar{X}$ = 16.60	$\bar{X}$ = 18.7	t = 3.044**

Note. From "Making Math Leaders: The San Francisco Math Leadership Project," by Carol R. Langbort,1990, *School of Education Review*, 2, p. 51. Copyright Spring 1990, by San Francisco State University.

$\bar{X}$ = mean score for number correct based on a total of 24 questions
*p<.10
**p<.01

Even after only one year, it is apparent that significant changes occurred in two major areas: increased versatility in the classroom and a strengthened learning component. In the area of classroom versatility, teachers reported that they were using varied strategies to teach computing skills, providing for differences in children's learning styles, and balancing the content among the different areas of mathematics. They also reported using a variety of math activities. In the learning component, teachers reported using manipulative materials to reinforce concepts, developing concepts from concrete to pictorial to symbolic, using activities that promote success, challenging children and encouraging divergent thinking and multiple approaches. Many of these approaches were used in the summer institute and the teachers were able to transfer them to their own classrooms. Many teachers described changes that they had made in their classrooms on an end-of-the-year evaluation. Following are one teacher's remarks.

Table 2
Teachers' self evaluation of their own classrooms

	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
	1987 n = 25		1988 n = 35		1989 n = 39		1990 n = 41		1991 & 1992 n = 44		1993 n = 30	
I CLASSROOM ATMOSPHERE												
a Atmosphere is positive and conducive to learning	2.2	2.1	1.9	1.4	2.1	1.4	2.7	2.4	2.0	1.5	2.2	1.8
b Teacher has high expectations	1.8	1.8	1.7	1.6	1.8	1.5	2.1	1.8	1.8	1.6	2.0	1.6
c Teacher is enthusiastic	1.8	1.7	1.6	1.5	1.8	1.3	2.3	2.1	1.6	1.5	1.8	1.5
d Structure builds confidence	2.2	2.2	2.1	1.9	1.9	1.9	3.0	2.3	2.4	1.5	2.3	1.7*
e Thinking is encouraged	2.1	2.0	1.9	1.7	2.0	1.7	2.2	1.9	2.2	1.4*	2.2	1.5*
f Students are grouped in variety of ways	2.5	2.1*	2.7	2.5	2.5	2.3	3.0	2.2	2.7	1.3*	2.4	2.0
g Children's work in evidence	2.3	2.0	2.1	2.0	2.3	2.1	3.0	2.2	2.2	1.8	2.3	1.8*
II CLASSROOM VERSATILITY												
a Varied strategies are used to teach computing skills	3.0	2.2***	2.8	2.2	3.0	2.3	3.3	3.4	2.7	1.5*	3.0	2.4
b Equal time given to mathematics	2.8	2.0**	2.7	2.0	2.7	2.5	2.9	2.5				
c Teacher provides for differences in students' learning style	3.0	2.4**	2.7	2.5	3.0	2.3	2.7	2.4	2.7	2.1	2.8	2.0*
d Variety of math activities are available for students use	2.9	2.1***	2.9	2.1*	2.9	2.1*	3.7	2.3**	2.7	1.6*	3.2	2.0*
e Overall content is balanced	2.9	2.2**	3.0	2.9	2.9	2.2	2.9	2.6	2.7	2.0	3.1	1.6*
III PROBLEM SOLVING AND THINKING												
a Emphasis on application in computing	3.0	2.4	2.9	2.4	2.9	2.3	3.0	2.6	3.1	2.2*	3.2	2.4*
b Process as well as product articulated	2.8	2.4	2.8	2.4	2.8	2.4	2.9	2.5	2.8	1.7*	3.0	1.8*
c Problems are formulated and analyzed	3.1	2.8	3.2	2.7	3.1	2.4	3.2	3.1	3.2	2.1	3.3	2.2*
d Students are encouraged to estimate and hypothesize	3.0	2.1***	3.0	2.2	3.0	2.2	2.8	2.3	2.9	2.5	3.1	2.2
e Teacher has a problem-solving plan	3.4	3.3	3.6	3.0	3.4	2.3	3.2	2.7	3.3	2.2*	3.4	2.2*
f Problems are used that have many right answers	3.4	3.0	3.5	3.0	3.4	2.4**	3.4	3.0	3.3	2.5	3.4	2.6
IV LEARNING COMPONENT												
a Manipulative materials are used to reinforce concepts	2.5	1.7***	2.6	1.8	2.6	1.4**	3.2	1.8*	2.3	1.6*	2.8	1.6*
b Concepts are developed from concrete to pictorial to symbolic	3.0	2.3**	2.8	2.0	2.9	1.8*	3.0	2.5	3.0	2.1	3.3	2.1
c Activities are used that guarantee success	2.8	2.0***	2.8	2.2	2.8	2.0*	3.5	2.4*	2.8	1.5*	3.5	2.2*
d Many approaches and divergent thinking are encouraged	2.8	2.1**	2.8	2.1	2.8	1.7*	3.3	2.2*	2.6	2.0	3.4	2.0
e Children enjoy math sessions	2.3	1.6**	2.7	1.8*	2.5	1.7*	3.2	2.3*	2.9	2.1	2.8	1.9
f Children are challenged	2.4	1.9**	2.6	1.7*	2.5	1.6*	2.7	2.1*	2.6	1.2*	2.9	2.2
g Children are writing in the math classroom	--	--	--	--	--	--	--	--	3.2	1.6*	3.0	2.2

Scale 1-2 = excellent, 3 = good, 4-5 = needs more focus, *p< 05, **p< 01, ***p< 001

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I think the major impact from my Math Leadership experience is the way I've taught math concepts. For example, problem solving was a language arts journal activity. I modeled problems using the children's names in the problem, which created more interest, writing it on the board. We read it together. We talked about whether we would add or subtract, should the answer be larger or smaller, etc. The class would read the problem, discuss it, write the math equation sentence, draw and illustrate the answer and finally act it out. We did this on a regular basis for weeks. The children would come up with their own problems, which really meant that they understood the concept and utility of adding or subtracting numbers. I have incorporated a lot of writing and processing which I would not have done previously.

Both content and pedagogy are essential in this Project and they are integrated as teachers learn or relearn mathematical concepts through a variety of pedagogical methods. Most of their own school learning of mathematics centered on memorizing rules and procedures with little chance for real understanding. Teachers reflected on their own learning through a variety of methods and recognized that some methods were preferable to them, while others preferred different methods. This process contributed to their effectiveness with their own students as well as their effectiveness in leadership roles.

Leadership Development

Leadership development is the central focus of the next section, where detailed information is presented about presentations at summer institutes, workshops at the teachers' schools, and the variety of leadership activities undertaken by these teachers.

There are two closely related components of the Project which are crucial to the leadership development of the teachers. The first occurs during the summer institute when the teachers must plan a presentation for their peers. The second is the requirement that they present two workshops at their school sites during the year. These components were part of the original project fifteen years ago and have continued to the present. Developing presentation skills within a supportive environment is a major factor in assisting these teachers to view their own potential for leadership.

Summer institute presentations.

Giving a presentation during the last week of the summer institute seems to be 'trial by fire' for many of the teachers. Most of the participants are nervous about this event. Two afternoons of the second week are devoted to preparation, and then, the actual presentations fill most of the slots during the final third week. The week is set up like a mini-conference, with a program of titles and speakers prepared in advance. Planning and presenting in pairs helps to alleviate some of the teachers' nervousness and provides an opportunity for pairs of teachers from the same school to work closely together.

By the time that teachers start planning for their sessions, they have already been involved in eight full days of workshops on a variety of topics. During these experiences the teachers are always trying to increase their knowledge of the mathematics while at the same time experiencing different models of presentation. These experiences give the teachers the opportunity to carefully consider the workshop elements that they like or dislike. Therefore, the first session on workshop preparation is devoted to brainstorming attributes of workshops: those items that contribute to the success of a workshop and should be included, and those that detract from it and should be avoided. Teacher participants from past years are given a leadership role as they are invited to return for the workshop presentation time to give assistance and advice to small groups of teachers as they plan their presentations.

Additional support is provided through resource books which aid the teachers in developing ideas that would be useful to them in this endeavor. With these resources, the teachers looked for activities and ideas that had not been presented in the previous two weeks. Teachers usually highlighted connections between specific aspects of the activities and the reform documents. Often the workshops reflected the bigger picture of mathematics reform. Knowledge about reform and ways to bring that back to their schools enhances the teachers' leadership skills. The teachers also work to include activities appropriate for several grade levels. Knowledge of the development of concepts across several grades enhances the workshop when the teachers present it at their school sites and also contributes to their development as leaders.

There is excitement in the air during the final week of the institute when most of the time is devoted to teachers' presentations.

And the presentations are characteristically quite professional and memorable. A special evaluation form was developed and is completed immediately following the presentation. The evaluation form queries about the content of the presentation, including the appropriateness, interest level, and difficulty level. Respondents are also asked to write about what they liked about the way the presentation was conducted and offer suggestions for improvement. Additional questions ask for any problems that the leaders could anticipate with an audience of teachers and any comments which would be helpful to the presenter. The audience completes this form immediately following the presentation. These are then returned to the presenters. During the final fifteen minutes of the presentation, the audience gives oral feedback to the presenters with a focus on the positive aspects of the session.

The presenters also fill out a self-evaluation. Presenters fill this out following their presentation. The questions include asking the presenter what they learned about organizing a presentation, what they would do differently in designing their next workshop, what worked, how it felt to plan together, and what would improve the process. The comments are used in subsequent years to assist others in preparing their presentations. These comments are often utilized during the introductory session on presentation preparation the following year. Giving this presentation seems to be a critical experience for the teachers. Many lack confidence in their ability to speak in front of adults and feel some insecurity in their ability to answer questions. Once they pass this milestone, they seem to increase their confidence and their leadership development is well under way.

Workshops at school sites.

During the school year following the institute, the teachers are required to give two workshops to teachers at their school sites. They need to make scheduling arrangements with their principals early in the school year, for often these workshops are scheduled as part of a faculty meeting. The teachers are encouraged to pair up to give these workshops. Often, the teachers are teaching different grade levels and are able to present an idea or topic that is appropriate across grade levels with each teacher presenting materials for their particular age group. The teachers are encouraged to try the activities with their own students prior to the workshops, so they can bring classroom anecdotes and students' work to share with the teachers. During the

summer institute, it was stressed that the teacher leaders did not need to be the final expert on a topic; the workshop was a way to share their experiences with their colleagues. This seemed to help alleviate some of their anxiety.

Most of the teachers are quite pleased with their presentations and with themselves. The event is generally more enjoyable than they had anticipated, and many find that they actually enjoy giving workshops. As a result, they easily became the math resource person at their schools; they are often asked for materials, suggestions for resource books, and were looked to as someone with a little more expertise in teaching mathematics. Two teachers expressed their thoughts about their new leadership roles:

> *My confidence as a math teacher has certainly grown and other teachers at my school are beginning to look to me as a resource. I find myself much more interested and eager to teach what I once considered beyond me.*
>
> *Giving workshops to other teachers helped me grow as a teacher. I was excited to share as much as I could. My neighboring 5th grade teacher used the "Seeing Fractions" unit with her class. I felt great as I saw her proudly display their work.*

Over the years, many letters have been received from principals following these workshops. They are most complimentary and truly appreciative of the quality of the workshops and the enthusiasm of their teacher leaders.

> *Both teachers have shared materials ordered through your program with other teachers on site. As a result of their renewed math enthusiasm, other teachers have requested like manipulative materials for classroom use. ...As a result of the workshops, there is renewed enthusiasm on the part of teachers and students school-wide.*
>
> *Our 5th grade teacher has given one inservice to the faculty which has been extremely worthwhile, informative, enthusiastic and well-done. I have seen how this has inspired and helped this teacher in the teaching of math in her class and her enthusiasm and expertise has inspired others...*

The project has essentially provided school principals with one or two teachers who are knowledgeable, interested and enthusiastic

about teaching mathematics. In addition, the principals have teachers to whom they can turn, to whom they can direct information about mathematics or recommend for district committees. Tenets of the reform movement in mathematics are thus brought to many schools in this way.

Leadership roles.

The leadership potential of project teachers is tapped with the completion of this first year. Following this experience, additional leadership opportunities must be provided to continue the growth and development of these teacher leaders. During the early years of the project, university professors designed and taught in the summer institute. After a few years, however, teacher leaders began emerging and formed a team of instructors which has lasted for many years. Each summer, a core of five to seven teacher leaders forms the team who plans and teaches in the summer institute. Additional teachers are invited back to give guest presentations on particular topics as well. Although some teachers have moved to positions outside the classroom, most often as principals or teachers on special assignment in the district office, the focus of this project is the classroom teacher and their leadership roles while they are classroom teachers.

Classroom teachers can exhibit leadership in a variety of ways. Several teacher leaders have written and received grants. Some of these grants provided funds for staff development at their sites; others provided money to buy manipulative materials for their classrooms or schools. A few teachers from different schools joined together to write a grant to support the development and presentation of math fairs at their schools. Two teacher leaders wrote articles for publication. "Designing Math Fairs" was published in the ComMuniCator, the journal of the California Mathematics Council (Schneider, 1990) and "Assessing Measurement in the Primary Classroom" was published in the National Council of Teachers of Mathematics 1993 Yearbook *Assessment in the Mathematics Classroom* (Sanford, 1993).

The school district has also provided leadership opportunities for our teachers. They have been asked to give workshops at schools not involved in the project and to develop short institutes with a particular content focus. One district sponsored a 4-Saturday Geometry Institute for teachers of grades 4-8, which was planned and taught by teachers from this project. Over the years, the teacher leaders from this project made up a large percentage of the pool of teachers from which

district committees were formed: some served on textbook selection committees, math curriculum development committees, Standards Writing Committee, and Assessment Item Writing Committee.

San Francisco Math Leadership teacher leaders played a pivotal role in an enormous undertaking by the San Francisco Unified School District. These teacher leaders provided professional development in mathematics over a three-year period (1994-1996) for all elementary teachers as support for implementing recently adopted curriculum materials. During this project 150 teachers were prepared to present workshops for the teachers from 76 elementary schools. Many project teachers were on the district team which designed and implemented this inservice program, and provided the professional development for the workshop leaders. Many others presented workshops in the schools.

Some teacher leaders have become regular speakers at local and state-wide math conferences. They have been appointed to state-wide committees involved in writing frameworks, or working on designing assessments. Several have been appointed as district math coordinators. One group of teachers planned and implemented a 20-hour professional development series with a focus on number sense for a group of 30 teachers from several local school districts.

Although there already existed in San Francisco one organization for math teachers, focused mainly on high school teachers, in 1989 a group of Math Leadership teacher leaders formed a new organization for teachers, the San Francisco Math T.E.A.M. (Teachers of Elementary and Middle School). This became an affiliate of the California Math Council and has organized several local math conferences. Even today, ten years later, the organization still exists, the officers are still Math Leadership teachers, and they continue to hold regular meetings and provide support for veteran and beginning teachers.

Perhaps the most important leadership roles occur at the school site on a day-to-day basis. Thirty-two respondents to a 1993 survey sent to project teachers in a subset of San Francisco schools provided information regarding their leadership activities at their sites. These teachers represented fourteen schools and had participated in the project during the years 1985 through 1992. Table 3 provides a summary of the extent to which these teachers have made an impact on their own schools. One teacher made the following comment:

Table 3. Teachers' Leadership Activities

Activity	Number	Percent	Range
Been asked by Another Teacher How to Teach a Math Concept	32	100%	4-50 times
Been Asked to Visit Another Teacher's Classroom to Observe And Give Feedback	13	40%	1-6 times
Been Asked by Another Teacher to Teach a Certain Concept or Demonstrate a technique	20	63%	1-50 times
Developed a Special Math-Related Event at Your School	20	63%	1-10 times
Organized Informal Discussions About the Teaching of Mathematics With Other Teachers in School	6	50%	2-50 times
Contacted or Met with Other SFML Teachers Outside Regularly Scheduled Meetings	17	53%	2-20 times
Used Computer Software to Teach Math	20	63%	'once' to 'daily'
Written a Grant Proposal to Improve Math Teaching	12	38%	'once' to 'twice'
Given an Inservice Workshop For Other Teachers on Math Education	15	47%	1-20 times
Presented a Workshop at a Local, State, or National Association Professional Meeting	4	13%	1-3 times
Published an Article on Math Education	2	6%	1 each, in progress

N=32

Note Adapted from *Results of Follow-up Questionnaire to Participants of San Francisco Math Leadership Project who are Teachers in Consent Decree Schools*, by Patricia M. Armstrong, Ph.D.1993.

> *I do believe one of the biggest changes is in the area of working with other teachers. I am trying to reach out and help others find different or new ways to present math in their classrooms....Teachers are beginning to ask for materials, suggestions and want to work as a team.*

Of the 11 activities listed, the majority directly impacted the lives of teachers and children at the school sites of the teacher leaders. Additionally, participants have been particularly active in the development of school-wide math events, including presenting workshops for parents, designing math fairs for parents and children (Schneider, 1989), developing a hands-on math lending library, and writing grants to purchase manipulative materials. Grant awards have ranged from $100 to $5000. Many of the leadership roles taken by teachers in the San Francisco Math Leadership Project provided examples for those described in the Mission Statement of the California Mathematics Project (1990). These are presented in Table 4.

Concluding remarks

One of the important things we learned about leadership development and the improvement of math teaching is that it takes time. The first year of active participation in the project is only the beginning. The networking that the project provides and the close ties that the teachers develop with teachers at different schools contributes to leadership development and support. The summer institute, where the teachers become enthusiastic about learning and teaching mathematics lays the foundation for their future work. When they return to their classrooms and teach math in new ways, they become excited about teaching and are building a repertoire of activities, and collect children's work and anecdotes that they will be able to share with others. The presentations that they give during the summer institute along with the workshops that they give at their schools help develop a new level of confidence that supports their new roles as teacher leaders. Many of the changes in classroom teaching and, concurrently, the changes in teachers' views of themselves as leaders emerge several years later.

The project opens the door for each teacher to become a professional. All have attended at least one major math conference during the first year of the project. For many teachers this is the first math conference they have ever attended. After attending a few conferences, they become confident in their own ability to speak

Table 4. Teacher Leaders

Who are Teacher Leaders?
A teacher leader in mathematics may be one who:
• fully implements a rich mathematics program in the classroom, setting an example for colleagues.
• tries new assessments in the mathematics classroom and shares the experience with the teacher next door.
• conducts 'beyond the bells' activities for mathematics students such as mathematics study groups, homework hotlines, mathematics clubs, mathematics teams, mathematics fairs, etc.
• works to provide resources at the school level, thereby raising the level of support for the mathematics program in the school.
• becomes a mentor teacher in mathematics, helping other teachers to improve mathematics instruction.
• serves on committees and works toward meaningful school/district mathematics improvements in the mathematics program.
• connects to the larger network of teachers seeking improvement in mathematics learning and encourages other teachers to become actively involved.
• becomes involved in the leadership of NCTM, CMC, or a local affiliate by serving as an officer or committee member.
• contributes to the leadership of a Mathematics Project as a site director, co-director, mentor or continuing active worker.
• connects to state or national staff development projects and committees helping to lead the effort and encouraging colleagues to take part.
• gets involved in a curriculum project helping to develop, pilot and evaluate new mathematics materials.
• participates in state or national assessment programs helping to design, score, and evaluate new mathematics assessments.
• learns a new technology, uses it in the classroom, and helps other teachers to use it.
• works with diversity/equity programs to make mathematics accessible to all students.
• works to bring more teachers of color into the effort to improve mathematics teaching and learning.
• learns techniques of teaching English language learners and works to apply these techniques to mathematics teaching.
• develops skills for presenting to colleagues and shares knowledge and experiences at mathematics meetings, workshops, institutes, etc.
• becomes a spokesperson for improving mathematics learning and makes presentations to school administrators, school boards, parents, community groups, government and the media.

Note. Adapted from the Vision Statement of the California Mathematics Project, 1990.

at a conference and team up with another teacher leader to present a workshop. By attending conferences each year they continue to grow in the area of mathematics education. Becoming a professional, first by joining organizations and attending conferences and then by serving on committees, becoming officers, organizing conferences and speaking at them, contribute to the development of leaders.

Leadership development requires time and it also takes various forms. All teachers who have participated in this project have given the two required workshops at their own school sites; many have continued to give workshops. Some, but not all, become interested in working with other schools, expanding their workshop repertoire and taking on an even greater variety of leadership roles. Others prefer to take on a variety of leadership activities at their own sites, such as those described in Table 3.

The district is not the only beneficiary of this work. The teacher preparation program at the university has also benefited. We have access to model classrooms in which to place credential students, both for observation and for their student teaching experiences. Several teachers have been appointed adjunct professors, teaching the math methods course for preservice teachers. Some project teachers who have retired from classroom teaching have returned to the university to supervise student teaching. One teacher recently earned her doctorate and is currently teaching methods and graduate level courses. Several others have earned masters degrees, with a concentration in mathematics education, in a new program specifically designed for classroom teachers (Langbort, 1998). Leadership takes a variety of forms, many of which cannot be predicted at the outset of an undertaking such as this Project. It is also difficult to predict which teachers will take on substantial leadership roles. It is important, however, to recognize the leadership potential in all the teachers, to encourage leadership in a variety of forms, and to reward those who do expand their professionalism in this way. Two teachers have summed up the impact of their experiences in the San Francisco Math Leadership Project in the following quotations:

> *It was very difficult for me to leave the text and venture into the unknown. The preparation was sometimes staggering, the timing sometimes off, and the room sometimes messy, but the results can be summed up by one of my parents who said, "my daughter is no longer afraid of math." That's it! That is what we're trying to achieve.*

Over the years I have turned toward the math textbook as my main vehicle for teaching mathematics. Through the last eight years, as I observed my colleagues who had attended Math Leadership, I was impressed with the materials these teachers shared with the staff at workshops....I noticed their classes were lively and interesting. Their students were engaged, enjoyed teamwork, and worked on long–range projects with great interest.... I needed new life in Math...A highly respected colleague told me Math Leadership would be a life-altering experience. After the training and exposure to the talented, lively staff (all women) for a year, I must admit I see changes and improvements in my approach to teaching Math....I am much more open to new ideas. I prepare new lessons, which the students really like. They no longer have to face my former 'turn to page 56' mentality. I am having fun experimenting with totally new concepts and lessons. Often I feel nervous now that I have left the boring path to Math. It is exciting. My enthusiasm is contagious. My students are comfortable working with most word problems....There is so much more to study and enjoy."

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